PLANTING MACHINE

BACKGROUND

FIELD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application Ser. No. 60/459,807, filed April 2, 2003, which is herewith incorporated herein by reference.

[0002] This invention relates in one embodiment to planting machines which are able to travel over the area of soil to be planted, open a furrow in the soil and continuously drop plants into the furrow. The furrow can then be immediately closed by the machine. An embodiment of this invention relates to the planting of plants which have developed in a nursery from seeds to a size which can be handled and can live in a farm field environment. Such plants are commonly referred to as "seedlings". In devices such as mechanical tobacco and pine tree planting machines, the seedlings are typically manually inserted into mechanical hands which place them in an opened furrow. In devices such as manual planting machines, the operator typically places the seedlings directly in the opened furrow by hand. In either type of known device, the furrow can typically be closed by the machine.

[0003] At the present time, many seedling plants, such as onions are planted by persons who manually place each plant in an indentation in the soil, then close, or tamp the plant secure in the indentation with a pressing motion of the hand. The soil indentations are often created by a cylindrical drum, provided with spikes placed in rows, and projecting radially from the drum. Such a drum can be axially mounted for free rotation and towed along the plant bed behind a farm tractor, forming the indentations as it rolls. Planting personnel walk or crawl along the area to be planted, carrying a supply of plants in one hand, placing and covering plants with the other.

[0004] Because of physical proximity of the furrows required for optimum plant density per acre, the size and shape of the planting mechanisms, and the space required on the planter for operating personnel, existing mechanical seedling planters are sometimes restricted to one operator per row of plants. Each operator on such known devices will, by hand, select and remove plant seedlings from a storage bin and place one plant seedling at a time in a delivery mechanism, which will deposit it in the previously opened furrow.

[0005] Since tobacco and tree seedling plants are comparatively large, and spacing along the row is large relative to the size of the plant, planting mechanism and operators, these systems are adequate to produce acceptable levels of production. However, in other applications, such as onion planting, where plants are tiny and spacing is approximately four inches along the row, they have not proved to be usable.

[0006] Other known systems use plant seedlings which have been grown in individual cups or multi-compartment trays. The uniformity of this type of holder for the plant makes an easy job for the machine to select and handle an individual plant seedling. Disadvantages of this system are the high cost of the special growing and handling equipment required, the complex mechanism required to coordinate the position of the plant tray with relation to the planting mechanism as well as the volume of storage space required on the planting machine to hold an adequate supply of plants carried in these containers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The benefits and advantages of the present invention will become more readily apparent to those of ordinary skill in the relevant art after reviewing the following detailed description and accompanying drawings, wherein:

[0008] FIG. 1A is a side view of one embodiment and also shows a farm tractor.

[0009] FIG. 1B is a side view of one embodiment and also shows a farm tractor.

[0010] FIG. 2 is a top view of a main frame.

[0011] FIG. 2A is a side view of a main frame.

[0012] FIG. 2B is a sectional view of a main frame.

[0013] FIG. 2C is a front view of a main frame.

[0014] FIG. 3 is a partial cross section of elements of a planting mechanism.

[0015] FIG. 4A is a top view of a planter drum.

[0016] FIG. 4B is a side view of a planter drum.

[0017] FIG. 4C is a front view of a planter drum.

[0018] FIG. 5 is a top cross-sectional view of a planter drum drive line.

[0019] FIG. 6 is a top view of a planter drum counter rotation drive.

[0020] FIG. 6A is a partial sectional view of a planter drum counter rotation drive.

[0021] FIG. 6B is a partial sectional view of a planter drum counter rotation drive.

[0022] FIG. 6C is a partial sectional view of a planter drum counter rotation drive.

[0023] FIG. 7 is a side view of a traction wheel travel stop.

[0024] FIG. 7A is a side view of a fender support post and keyhole cut-out.

[0025] FIG. 7B is a front view of a traction wheel travel stop.

[0026] FIG. 8 is a side view of a floating skid assembly.

[0027] FIG. 8A is a bottom view of a floating skid assembly.

[0028] FIG. 8B is a top view of a floating skid assembly.

[0029] FIG. 8C is a rear view of a floating skid assembly.

[0030] FIG. 8D is a cut-away view of an area of the floating skid frame of the skid belly.

[0031] FIG. 8D is a view of a planter plow.

[0032] FIG. 9 is a view of a of plant chute.

[0033] FIG. 9A is a cross-sectional view of a of plant chute.

[0034] FIG. 10 is a side of an air nozzle.

[0035] FIG. 10A is a cross-sectional view of an air nozzle.

[0036] FIG. 10 is a view of an air nozzle with air hose.

[0037] FIG. 11 is an air compressor drive line.

[0038] FIG. 11A is a side view of part of an air compressor drive line.

[0039] FIG. 12 is an air supply circuit.

DETAILED DESCRIPTION

[0040] While the present invention is susceptible of embodiment in various forms, there is shown in the drawings and will hereinafter be described a presently preferred embodiment with the understanding that the present disclosure is to be considered an exemplification of the invention and is not intended to limit the invention to the specific embodiment illustrated. It should be further understood that the title of this section of this specification, namely, "Detailed Description Of The Invention", relates to a requirement of the United States Patent Office, and does not imply, nor should be inferred to limit the subject matter disclosed herein.

[0041] In the present disclosure, the words "a" or "an" are to be taken to include both the singular and the plural. Conversely, any reference to plural items shall, where appropriate, include the singular.

[0042] Referring to the drawings, an embodiment of the present invention, directed to a method and apparatus for manufacturing an aluminum MMC (Metal Matrix Composite) disk rotor, is now explained in detail.

[0043] Various embodiments of the invention can accomplish some or all of the following objects. An embodiment of this invention includes, for example, a planting machine which utilizes more than one operator per row of plants. Another embodiment includes, for example, a planting machine which will dispense seedling plants in a regular, uniformly spaced pattern, providing a desirable optimum growing space for each plant. Another embodiment includes, for example, a planting machine which will dispense seedling plants at a large number of plants per unit of travel, maintaining desirable close plant spacing. Another embodiment includes a planting machine which will dispense seedling plants at a high rate of plants per unit of time, maintaining a desirable high rate of production. Another embodiment includes, for example, a planting machine which will carry a supply of seedling plants in sufficient quantities to allow for optimum utilization of the planting machine in fields where rows are of great length and require many plants to fill. Another embodiment includes, for example, a planting machine which will be easily carried by the three point hitch system of a standard farm tractor and obtain all required operating power from the tractor. Another embodiment includes, for example, a planting machine which will shape the soil of the plant bed for optimum plant growth and production. Another embodiment includes, for example, a planting machine which will allow for easy adjustment of plant spacing along the row, to accommodate variations in mature plant size and growing practice. Another embodiment includes, for example, a planting machine which will plant at a higher rate of production when compared to existing planting methods. Another embodiment includes, for example, a planting machine which does not require special preparation of the seedlings, individual holding containers and large volume storage areas on the planting machine. Another embodiment includes, for example, a planting machine which will allow use of seedling plants packaged in bundles and packed in industry standard crates as is common practice in current manual planting operations. Another embodiment includes, for example, a planting machine in which the seedling dispensing mechanism will be driven by a traction wheel impelled by contact with the ground surface as the unit is moved over it. Those of skill

in the art may recognize other and further objects, advantages, and embodiments of the invention from a consideration of the ensuing description and accompanying drawings. It is the applicants intent that such variations are encompassed within the scope of this disclosure and the claims below.

[0044] FIG. **1A** illustrates planting machine **1** attached by three-point hitch frame **31** to a conventional farm tractor. Tractor power take off (PTO) shaft **54** connects planting machine air compressor drive to tractor PTO output shaft. Operators sit on seats **35** facing the planter console **2** from opposite sides. Four operators on opposite sides of console (eight operators total) are each positioned in front of, and in close proximity to a plant collecting and dispensing device, which in the case of one embodiment, is an axially mounted rotatable planter drum **3**. A traction wheel **41** is shown in this embodiment operably connected to rotatable planter drum **3**. FIG. **1A** illustrates planting machine in planting position, with machine level and in contact with ground area to be planted. FIG. **1B** illustrates planting machine in raised, travel position with all elements of machine clear of ground.

[0045] FIG. 2, FIG. 2A, FIG. 2B, and FIG. 2C illustrate planter mainframe as constructed in one embodiment. The mainframe comprises several welded steel elements, among them three-point hitch frame **31** and main frame rails **30**. Main frame rails **30** are connected to each other by cross members **32** and **36,** and the pan structure **25** shown in Fig 2A, Fig 2B, and Fig 2C. Cross-member **32** in the embodiment shown in Fig 2, Fig 2A, and Fig 2B is an elongated tube which extends beyond frame rails **30,** to provide a mount structure for attachments associated with planting process, such as, for example, sweep plows and chemical spray equipment. Cross member **36** serves in the pictured embodiment as mounting structure for skid downforce spring **24** pictured in FIG. 3. Pan structure **25** is a sheet steel weldment comprising a ski shaped center section and two opposing side panels. Center section of pan structure **25** supports air compressor pump mount **33**, both depicted in Fig 2B. Other frame elements depicted in this embodiment include floorboards and plant storage area **84**, running boards **85**, and operator seats **35**, fender **27** and support post **28.**

[0046] FIG. **3** illustrates an arrangement of planting machine elements in one exemplary embodiment. Mechanism for planting one row of plants comprises in this embodiment opposing pairs of planter drums **114**, chute **22**, floating skid **86** with plant guide **112**, furrow opening plow blade **108**, furrow widening plow wedge **109**, and furrow closing fins **91**. Console **2** is securely attached to frame rails **30** in one embodiment by welding or other suitable means. Floating skid **86** in one embodiment is pivotally mounted on frame

cross member **26** and forced against the earth by skid downforce spring **24**, acting between frame cross member **36** and floating skid arch **45**.

[0047] FIG. 4, FIG. 4A, and FIG. 4B illustrate planter drum **114** mechanism in one embodiment. Planter drum mechanism comprises a two-part cylindrical drum **115**, spoked web **116**, hub **117**, plant carrier flights **122**, together with air nozzle mount **118**, air nozzle **71**, and air supply hose **58**. Air nozzle mount **118** is rotatably mounted on drum shaft **5,13** so that angle of air nozzle **71** relative to a level position is adjustable through range of travel of clamp plate **123**, and is secured in place to frame bar **119** by lock bolt **120.** Two parts of cylinder drum **115** are separated by a narrow circumferential slot **121**. Slot **121** is provided for passage of air from nozzle **71** to plant carrier flights **122,** and in the preferred embodiment, divides cylindrical drum **115** into two parts, longer part being approximately three-fourths of total length, shorter part being approximately one forth of total length. Two parts of cylindrical drum **115** are connected by multiple plant carrier flights **122**, flights being secured to both cylinder parts by welding, bolting or other suitable means. Planter drum mechanism **114** is mounted on rotatable shaft **5, 13** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means.

[0048] FIG. **5** illustrates drive line from traction wheel **41** to drum shaft **13** in one embodiment. Traction wheel **41** is removably mounted on axle **43** which is, in turn rotatably mounted in bearings **64**. Bearings **64** are opposedly mounted on sides of traction wheel arm **50.** Traction wheel arm **50** is, in turn pivotally mounted to mainframe rail **30** by mount **29**, bearings **74** and axle **45**. Bearings **74** are opposedly mounted on sides of arm **50.** Axle **45** is mounted within hollow tubular body of mount **29** and secured and positioned by bolt **69** or other suitable means. Thus, traction arm **50**, together with all components attached thereto, is mounted for rotation about axle **45** with said axle securely attached to mainframe rail **30**.

[0049] Further with reference to an embodiment depicted in FIG. **5,** sprocket **42** is attached to axle **43** and secured from rotation relative to axle by keyway and setscrew or other acceptable means. Other components including sprocket **39** and sprocket **40** and the planter drum wheel **14** are rotatably linked to sprocket **40** by drive chain **65**. Sprocket **39** and sprocket **40** are mounted for rotation on axle **45**, supported by shoulder sleeve bearing **67** and washer **75**. Sprocket **39** and sprocket **40** are connected and prevented from rotation, one relative to the other, by drive pin **76** or other suitable means. Sprocket **39**, sprocket **40,** shoulder sleeve bearing **67** and washer **75** are retained on axle **45** by ring collar **66** which is secured in position by setscrew or other suitable means.

[0050] Further with reference to an embodiment depicted in FIG. **5**, bearings **16** are securely mounted to table shelf frame **19** and support opposite ends of jackshaft **15**. Sprocket **38** is mounted on jackshaft **15** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Sprocket **38** is rotatably linked to sprocket **39** by chain **37**. Sprocket **17** is mounted on shaft **15** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Sprocket **17** is rotatably linked to sprocket **20** by chain **18**. Sprocket **20** and planter drum **114** are mounted on shaft **13** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Bearing **21** is securely mounted to table shelf frame **19** and supports one end of shaft **13**. Thus, traction wheel **41** is, through axle **43**, sprocket **42**, chain **65**, sprocket **40**, drive pin **76**, sprocket **39**, chain **37**, sprocket **38**, jackshaft **15**, sprocket **17**, chain **18**, sprocket **20**, and shaft **13**, linked for rotation to planter drum **114**. Number of teeth in sprockets **42, 40, 39** and **38** determine final ratio of rotation between traction wheel **41** and drum **114.**

[0051] FIG. **6, FIG. 6A, FIG. 6B, and FIG. 6C** illustrate system used in one embodiment to obtain required opposite directions of drum rotation. Many methods exist that could obtain the same result, and the invention is not limited to system employed in the pictured embodiment.

[0052] Partial section **AA** in FIG. 6A further illustrates elements also shown in FIG. **5** which rotatably link traction wheel **41** to jackshaft **15**.

[0053] Partial section **BB** in FIG. 6B further illustrates rotation reversing system. In the embodiment depicted, sprocket **14**, together with sprocket **17** and sprocket **38**, is mounted on jackshaft **15** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Idler sprocket **12** is mounted for free rotation on shaft **13** and supported on shaft by bushing **11**. Sprocket **23** is mounted on shaft **5** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Chain **10** is routed over sprocket **23** and idler sprocket **12**, and under sprocket **14**. Sprocket **23** and sprocket **14** in the illustrated embodiment have the same number of teeth.

[0054] Partial section **CC** in FIG. 6B further illustrates rotational linkage between jackshaft **15** and drum shaft **13**. In the embodiment depicted, sprocket **17** is mounted on jackshaft **15** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Sprocket **20** is mounted on drum shaft **13** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Sprockets **17** and **20** have the same number of teeth and are linked for rotation by chain **18**.

[0055] FIG. 7, FIG. 7A, and FIG. 7B illustrate in one embodiment traction wheel arm **50**, which is pivotally mounted to mainframe rail **30** by mount **29**, bearings **74** and axle **45**. In the embodiment depicted, link chain **46** is securely attached to arm **50** by welding or other suitable means. Fender support post **28** is provided with keyhole cutout **81**, cutout being of a diameter sufficiently large to allow easy passage of chain through it. Cutout is provided with connected slot of correct width and length to accept and retain single link of chain **46**.

[0056] FIG. 8, FIG. 8A, FIG. 8B, FIG. 8C, FIG. 8D, and FIG. 8E illustrate in one embodiment a mechanism used to open a furrow in the earth to be planted, and to close the furrow thus opened and containing seedling plants. Floating skid frame **86**, in the depicted embodiment, is constructed of welded metal or other suitable material and comprises an elongated body with tube **87** at forward end and arch **95** at trailing end. Tube **87** is provided for pivitable mounting to planter frame member. Skid belly **88** is constructed of abrasion resisting material and is attached to skid frame **86** through capture by retaining angle cross member **90** and mounting bolts **89**, or other suitable means. Furrow closing fins **91** are constructed of abrasion resisting material and are adjustably and opposidly mounted to the bottom surface of skid belly **88**. Furrow closing fin **91** is mounted for rotation about bolt **92**, being secured in its adjusted position by bolt **94**. Slot **93** in skid belly **88** is located concentric with center of bolt **92** and allows required range of angular adjustment for furrow closing fin **91.** FIG. **8D** is a cut-away view of the area of floating skid frame which exposes bolts **92** and **94**.

[0057] Further with reference to the embodiment depicted in FIG. 8, FIG. 8A, FIG. 8B, FIG. 8C, FIG. 8D, and FIG. 8E, plant guide **112** is of a funnel shape and is adjustably mounted on skid frame **86** and retained in position by bolts **113**. Plant guides **112** are, in the preferred embodiment, asymmetrical in construction, being offset away from the centerline of the machine for improved travel of the seedling plant into the open furrow.

[0058] Further with reference to the embodiment depicted FIG. **8E** illustrates planter plow which, in the preferred embodiment, is constructed of abrasion resisting material and comprises blade **108**, and wedge, **109**. Wedge shape is attached to blade by welding or other suitable means. Blade is provided with holes **110** for adjustable mounting in skid frame **86**, and is retained in position by bolts **111**.

[0059] FIG 9 and FIG. 9A illustrate in one embodiment chute **22**, which in the depicted embodiment comprises an elongated, tapered hollow channel shell of rectangular cross section. In the depicted embodiment, a lengthwise portion of channel at broad end of

taper comprises four joined sides, with remaining length of channel comprising three sides only. Air nozzle **55** is securely mounted on shortened fourth side **9** by welding, clamping or other acceptable means, with lengthwise axis of nozzle aligned with elongated axis of channel and with nozzle exit end directed toward narrow end of taper.

[0060] FIG. 10 and FIG. 10B illustrate in one embodiment construction of air nozzle **55** and air nozzle **71**. In the embodiment depicted, sprag type push-on threaded hose fitting **128** of size matching hose **58** is threaded into one end of standard pipe coupling **130**. Similar fitting **129**, with matching thread size, is threaded into opposite end of coupling. Push-on sprag of fitting **129** which serves as flow-restricting nozzle. In the embodiment shown, push-on barb is sized for 1/8 inch hose, giving an exit orifice diameter of approximately .05 inches.

[0061] FIG. 11 and FIG. 11A illustrates in one embodiment drive line from tractor PTO shaft **80**, to planter air compressor pump **47**, as employed in the depicted embodiment. Universal joints **79** and shaft **54** is a common agricultural driveshaft assembly as commonly used on pieces of PTO driven farm machinery. Jackshaft **51** is retained and supported by bearings **63**, located near opposite ends of the shaft. Bearings **63** are removably mounted to plate **34**, which is a component of planter frame.

[0062] Further with reference to the embodiment depicted in FIG. 11 and FIG. 11A, driveshaft assembly is mounted on one end of jackshaft **51** and secured from rotation relative to shaft by keyway and setscrew or other acceptable means. Pulley **48** is mounted on end of jackshaft **51** opposite driveshaft assembly end. Pulley **52** is securely attached to pump flywheel **53** by bolts, welding or other suitable means. Pulley **48**, belt **49** and pulley **52** comprise a means to transmit rotational power from jackshaft **51** to air compressor pump **47** at a desired speed of rotation relative to tractor PTO speed.

[0063] FIG. **12** illustrates planter air supply system as employed in the depicted embodiment. Tractor PTO driven air compressor pump **47** is connected by air hose **56** to check valve **62**. Compressor pump **47** is provided with an unloading valve **61**, which suspends pumping function when air pressure in storage tank **58** reaches a preset level. This action reduces heat buildup in compressor pump and provides for more efficient pump operation than would releasing excess high pressure air to the atmosphere. Check valve **62** is connected to air supply storage tank **59** by hose **56**. Hose **56** in each instance is rubber push-on hose, connected to attached components by threaded sprag type fittings, or other suitable means. Air supply storage tank **59** is provided with air pressure safety release valve **82**, and drain valve **83**. Air supply storage tank **59** is connected to filter regulator set **57** by hose **56**.

Filter regulator set **57** is a standard commercial unit, of common use in industry. Using a standard tee fitting, hose **56** is divided at point "X" into two equal branches, "A" and "B". Branch "A" supplies air to 4 planter drum and chute nozzles shown, while branch "B" supplies air to an additional set of 4 planter drum and chute nozzles of same design and construction as those shown. Hose **56** is divided at a point past point "X" into 4 branch hoses **58**, each branch further divided to supply air to one drum nozzle **71**, and one chute nozzle **56**.

[0064] It will be appreciated by those of ordinary skill in the art that the air hose 56 can be any known or hereafter developed means for providing a blast of air or similar gas or liquid to facilitate planting of seedlings. Pneumatic or hydraulic devices of other kinds to produce jets of air or liquid can also be used for such a purpose and are considered within the scope of the invention.

[0065] With reference to the operation of one embodiment of the invention, FIG. 1A and FIG. 1B illustrate one embodiment of the planting machine **1** attached by three point hitch **31** to a standard farm tractor. Tractor power take off (PTO) shaft **54** connects planting machine air compressor drive to tractor PTO output shaft. Operators sit on seats **35** facing the planter console **2** from opposite sides. Four operators on two opposite sides of the console (eight operators total) are each positioned in front of, and in close proximity to a plant collecting and dispensing device, which in the case of the preferred embodiment, is an axially mounted rotatable planter drum **3**. FIG. **1A** illustrates planting machine in planting position, with machine level and in contact with ground area to be planted. For travel outside the planting operation, turning around at the end of a planting row and other non-planting operations, a tractor towing the depicted embodiment can use three point hitch **31** to raise planting machine clear of the planting surface as shown in FIG. **1B.**

[0066] Further with reference to the operation of the embodiment depicted in FIG. 1, the planting machine **1** opens one or more furrows in soil to be planted, deposits seedling plants at regular spaced intervals, and closes opened furrow, securing planted seedling in a virtual upright position at correct planted depth for proper growth.

[0067] When the planting machine is lowered into correct position for contact with ground area to be planted as illustrated in FIG. 3 for one embodiment, skid **86**, which comprises plow blade **108** and wedge **109** will be level with, and in solid contact with the soil area to be planted. As tractor moves planting machine over ground area to be planted, plow blade **108** opens furrow to the correct depth as determined by position of plow in skid frame **86**. Furrow is widened to accept seedling plant by wedge **109**.

[0068] Further with reference to the operation of the embodiment depicted in FIG. 3, each operator, positioned in front of a rotating planting drum **114**, is furnished a supply of seedling plants stored in easy reach on the planting console **2**. In the depicted embodiment, planting drum **114** is mounted inside console **2**, with a small sector exposed to operator. As planting drum **114** rotates, empty flights **122** are exposed to operator, each flight rising from the console and moving away from the operator's position. Operator manually drops seedling plants into spaces between moving flights **122**, with root end of plant positioned toward slot **121** end of planter drum.

[0069] Seedling plants in one embodiment are carried in planter drum to a position, as seen in FIG. **4**, near air nozzle **71**. Air nozzle **71** provides a constant blast of air directed through slot **121**, and into space between flights **122**. As seedling plant passes past air blast of nozzle **71** it is blown off flight **122** and is free to fall down chute **22**. Root end of seedling plant is heavier and more dense than leaf end, causing plant to fall root end down as it is ejected from planter drum **114**,

[0070] Further with reference to the operation of the embodiment depicted in FIG. 4, seedling plants are of inconsistent weight, density and shape among various species, crops, and growing areas, hence effect of air blast from nozzle **71** varies with different plant characteristics. To compensate for differences in effect of air blast, angular position of nozzle mount **118** with relation to position of plant to be ejected from drum can be adjusted for earlier or later ejection of plant from planter drum. Adjusted position is maintained by clamp plate **123** which is secured to frame bar **119** by lock bolt **120**.

[0071] Although plants in the embodiment depicted will typically drop from planter flights without application of air blast, radial position of release point may be inconsistent and may vary greatly from plant to plant within the same plant group. With required spacing of 4 inches and travel speed of one foot per second, a slight variation in plant release point between to plants can cause great variation in plant spacing. Precise angular positioning of nozzle relative to plant to be ejected causes plant to be released to fall free at the same instant and position from one plant to the next.

[0072] As shown in FIG. 3, in one embodiment opposing planter drums which dispense plants into the same furrow are set up with flights one-half space out of time with relation to air nozzle **71**. As one planting drum passes into nozzle air blast in the depicted embodiment, its opposing planter drum is positioned for one-half flight space delay to reach nozzle blast. This alternating ejection of plants from opposing planter drums results in even spacing of plants along planted row.

[0073] As illustrated in FIG. **9**, in one embodiment the planting machine is provided with a plant chute **22** for each pair of opposing planter drums, with opposing drums alternately ejecting plants into the same chute. In applications where plant density along the planted row is less, only one planter drum, utilizing the same features and elements set forth here, may be required to meet planting rate needs. Chute **22** is provided with full length sides on three surfaces and a shortened side on one surface. In cases where plants will occasionally clump together during travel from ejection from planter drum to position in open furrow, open side of chute will allow plant clump to fall free from chute without congesting chute and disrupting planting operation. In order to maintain travel path of a plant away from open side of chute and to accelerate plant toward furrow, an air nozzle **55**, is positioned on shortened side of chute **9**, with its air flow directed toward furrow. Nozzle **55** air flow forces falling plant to move toward opposite of chute. Air flow from nozzle **55** is not adequate to force a clump of plants to opposite wall, so clump will fall free and out of open side of chute. Free falling seedling plants fall at varying rates depending on plant characteristics of weight and aerodynamic drag of the leafy end of plant, a leafy, light weight, plant falling more slowly than a relatively heavy plant with few leaves. When propelled by air flow of nozzle **55**, plants tend to travel at a more uniform rate, with light, leafy plants being accelerated by air flow to a greater degree than relatively heavy plants with few leaves. This equalization of travel speeds results in a more uniform spacing of plants along planted row.

[0074] With reference to FIG. **3** and FIG. **8**, in one embodiment plants move from chute **22** to plant guide **112**, which directs plant into open furrow. In order for plant to be captured by soil in proper, erect position, furrow must close around plant at correct instant. Plant guide **112** is adjustably mounted on skid frame **86** for positioning at various depths relative to the open furrow. Closing of the open furrow on plant is controlled by depth of plant guide **112** relative to open furrow. As plant guide **112** is lowered into furrow closing of furrow is delayed by interposing side walls of plant guide. As position of plant guide **112** is raised relative to furrow, less area of side walls is interposed between plant and closing furrow. Adjustability of planting guide **112** depth allows planter to compensate for various soil conditions, with guide being raised for dense, stiff soils and lowered for sandy, soft soils.

[0075] As shown in an embodiment depicted in FIG. 3, Skid **86** is pivotally mounted on frame cross member **26**, a round rod of correct diameter to allow free rotation of tube **87**. Spring **24** applies downward force on arch **95** and hence to skid **86**. Skid belly **88** slides along soil of planting area, and due to downward force of spring **24** and pivotal

mounting on cross member **26**, maintains constant contact as soil level rises or falls with relation to planting machine.

[0076] As shown in an embodiment depicted in FIG. **8**, skid **86** is provided with opposedly mounted furrow closing fins **91**. It is the purpose of fins **91** to further compact the soil as it captures plant and return soil displaced by plow blade **108** and wedge **109** to the furrow. Fins **91** project downward into soil and converge relative to each other at trailing ends. As skid moves along furrow, converging arrangement of fins **92** scrapes displaced soil back into furrow and together with smoothing and compacting action of skid belly **88**, further compacts soil around plants.

[0077] Planter drum **114** is driven in rotation by a series of chain linkages from traction wheel **41**. Traction wheel **41** together with arm **50** is pivotably mounted on axle **45** with sufficient unrestricted travel to allow full contact of wheel with ground when planter is lowered into planting position. Traction wheel **41** together with arm **50** is attached to planter frame rail **30** by mount **29**. Weight of Traction wheel **41**, arm **50**, and attached components such as chain drive, generates sufficient downward force to drive traction wheel in rotation as planter is moved over the area to be planted. As illustrated in FIG. **7**, traction wheel is limited in downward travel by chain **46**. Downward travel limit is set by adjusting length of chain between arm **50** and keyhole **81**. Chain is adjusted for required up and down movement of traction wheel **41** during planting process and sufficient ground clearance while in a raised position, as shown for one embodiment in FIG. **1**.

[0078] Spacing of plants along row in one embodiment is determined by relation of distance traveled by traction wheel **41** and number of flights **122** moving past air nozzle **71.** By way of example, in one embodiment the distance traveled in one rotation of traction wheel is 60 inches, the drive ratio between traction wheel and planter drum is 1:1, and the number of flights on drum is 20. In this example, 20 plants would be planted in 60 inches of travel, giving a plant spacing of 3 inches. By changing number of teeth on one or more drive sprockets in drive chain from traction wheel **41** to jackshaft **15**, any desired ratio, and hence any plant spacing along the row, may be obtained.

[0079] FIG. 6, FIG. 6A, FIG. 6B, and FIG. 6C illustrate in one embodiment a system used in the preferred embodiment to obtain required opposite directions of drum rotation. Many methods exist that could obtain the same result, and the invention is not limited to system employed in the preferred embodiment.

[0080] FIG **6A**, illustrates in one embodiment elements also shown in FIG. **5** which rotatably link traction wheel **41** to jackshaft **15**. All changes in drive ratio to alter

spacing of plants along planted row must be undertaken between sprockets **42** and **40**, and between sprockets **39** and **38**.

[0081] Partial section FIG. 6B illustrates in one embodiment rotation reversing system. In the depicted embodiment, sprocket **14**, together with sprocket **17** and sprocket **38**, is mounted on jackshaft **15**. Idler sprocket **12** is free to rotate on shaft **13.** Sprocket **23** is rigidly mounted on shaft **5**. Chain **10** is routed **over** sprocket **23** and idler sprocket **12**, and **under** sprocket **14**. Sprocket **23** and sprocket **14** have the same number of teeth. As jackshaft **15** is driven in a counter-clockwise rotation, sprocket **23** and hence shaft **5** will be driven in a clockwise rotation. To maintain coordinated rotation between opposing planter drums, sprockets **23** and **14** must have the same number of teeth.

[0082] Partial section FIG. 6C illustrates in one embodiment rotational linkage between jackshaft **15** and drum shaft **13**. Sprocket **17** is rigidly mounted on jackshaft **15**. Sprocket **20** is rigidly mounted on drum shaft **13**. Sprockets **17** and **20** are linked for rotation by chain **18**. To maintain coordinated rotation between opposing planter drums, sprockets **17** and **20** must have the same number of teeth.

[0083] Planter is provided in one embodiment with pressure air system as illustrated in FIG. **12**. In the embodiment depicted, air compressor pump **47** provides supply of compressed air to operate drum nozzles **71** and chute nozzles **55**. Air compressor pump is provided with unloading valve **61**, which relieves pressure pumping load and circulates free air through the pump for cooling. Unloading valve **61** is operated when pressure in air tank **59** reaches a pre-set value. In one embodiment pump is active 75% of time and in non-pumping cooling mode 25%. Check valve **62** holds tank pressure when unloading valve operates, and relieves start-up load on pump when tank is at high pressure. Filter regulator set **57** is common commercial unit as found in industry. Filter guards against clogged nozzles and regulator reduces pressure from 100-125 p.s.i. air tank **59** pressure to 30-40 p.s.i. nozzle working pressure. Air system branches in one embodiment at point "X" on FIG. **12** to furnish air to similar set of planter drum and chute nozzles as those shown. Tank is provided with safety relief valve **82** which operates in case unloading valve fails and tank pressure reaches unsafe levels. A water drain valve **83**, is installed at low point of air tank.

[0084] Air compressor pump in one embodiment is driven by carrying tractor's PTO output. Drive in one embodiment is illustrated in FIG. **11**. Depending on tractor's PTO speed, either 550 or 1000 r.p.m, the size of pulleys **48** and **52** are selected in one embodiment to provide a pump operating speed of 1200 to 1500 r.p.m. with tractor engine at planting travel speed.

[0085] From the foregoing it will be observed that numerous modifications and variations can be effectuated without departing from the true spirit and scope of the novel concepts of the present invention. It is to be understood that no limitation with respect to the specific embodiments illustrated is intended or should be inferred. The disclosure is intended to cover by the appended claims all such modifications as fall within the scope of the claims.